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RASPBERRY CULTURE

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THE RASPBERRY is grown not only in small plantations for the home and local market but in some sections as the principal commercial crop. In these localities the raising of raspberries has become highly specialized, and methods of growing that are peculiar to this industry are employed.

This bulletin furnishes information on the best methods of raspberry culture and particularly considers practices that differ from those used with other bush fruits. Varieties are listed, characterizations of the leading sorts and their adaptations are made, and the autumn-fruiting sorts are discussed. The varieties preferred for canning and preserving are listed, and directions for their utilization are given.

The cultural directions are based on practices that have proved highly successful in different sections. Where experiments have indicated improvements on former methods their results are given. The practices may require modification in some particulars to meet local conditions, but they will be of value to those whose experience in raspberry culture is limited.

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RASPBERRY CULTURE

By **GEORGE M. DARROW**, *senior pomologist*, and **GEORGE F. WALDO**, *assistant pomologist, Division of Fruit and Vegetable Crops and Diseases, Bureau of Plant Industry*

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INTRODUCTION

THREE types of raspberries (red, black, and purple) are grown extensively in the United States. Red raspberries bear red fruit, have erect canes, and usually are propagated by the suckers which come from the roots of the parent plant. Some of the varieties under cultivation come from the European and the rest from the American wild red raspberry or are hybrids of these two types. Among the leading red varieties are the Cuthbert, Ranere, and Latham.

Black raspberries, or blackcaps, bear black fruit, have arched canes which root at the tips in the autumn, and are propagated by the plants formed at the tips. All black varieties come from the American black raspberry, which grows wild in the eastern part of the United States. Under cultivation they are not, however, as hardy as some of the red varieties that come from the American wild red raspberries. The Cumberland, Farmer, and Munger are the most important commercial sorts of the black type.

The varieties under cultivation bearing purple-colored fruit are hybrids between the red and black raspberries and have canes that arch and root at the tips, as do the black raspberries. The Columbian, Potomac, and Sodus are leading purple sorts.

Occasionally plants of the red, purple, and black types are found to bear yellow fruit, but the yellow varieties in cultivation belong to the red-fruited type. The Golden Queen is the leading yellow-fruited variety. It is rarely grown for the general market, but is adapted to home gardens and to special markets.

Figures 1 and 2 show the difference between the fruit clusters of the red and black varieties.

The cultivation of the raspberry is limited largely to the northern part of the United States, chiefly to those sections where the wild raspberries grow most abundantly. Since the introduction of the Ranere, commercial raspberry plantings have succeeded as far south as Atlanta, Ga.



FIGURE 1.—A fruit cluster of the Loudon (red) raspberry.

few plantations in the Southern States or in California.

The purple varieties are grown extensively only in western New York, although for local market and home use their range is about the same as that of the blackcap.

CONDITIONS NECESSARY FOR RASPBERRY GROWING

Particular attention should be given to the locality in which the raspberry plantation is to be established.

The hot summers of the South are not favorable to production of this fruit, which is a native of cool climates. There are few plantations south of Virginia, Tennessee, and Missouri, and even the warmer parts of Virginia and Tennessee are not well adapted to raspberry growing. The black varieties are not widely grown on the Pacific coast, except in the Willamette Valley of Oregon. In most of the

The red-raspberry sections from which extensive shipments are made are located in western Maryland, in southern New Jersey, in the Hudson River Valley, in western New York, in western Michigan, near Minneapolis, Minn., and in the Puyallup Valley of Washington, the Willamette Valley of Oregon, and the Santa Clara Valley of California.

Black raspberries are grown for commercial shipment in western New York, in western Michigan, in the sections about Wathena, Kans., and Hagerstown, Md., in the Willamette Valley of Oregon, and to a less extent in other places. There are

Great Plains area and in parts of the Mountain States of the West the winters are too severe or the summers too hot and dry for raspberry growing.

The raspberry plantation should be located near a good market or good shipping point if it is to be most profitable. The roads to that market or shipping point should be such that the berries will not be injured when hauled over them. If the fruit is to be shipped long distances it is essential that quick transportation and refrigerator-car service be available.

Three important factors that should be considered in the selection of a site are the soil type, the moisture supply, and the air drainage.

The raspberry succeeds on a wide range of soil types provided suitable moisture conditions prevail. A fine, deep, sandy loam is perhaps the most desirable soil for growing raspberries, because it is managed so easily. Equally good yields of some varieties will be secured on clay and on sandy soils if they are well managed. In general, the black raspberries seem to do best on sandy soils, but they are also grown extensively and succeed well on clay soils.

Among the red raspberries the Ranere does best on sandy types, but the June succeeds best on a clay soil. Other varieties, such as the Cuthbert and Latham, succeed on a wide range of soil types. Where the soil requirements of varieties are known, they are indicated in the characterizations given in later pages of this bulletin.



FIGURE 2.—A fruit cluster of the Cumberland (black) raspberry. Contrast the stiff, prickly fruit stems here shown with the slender, drooping stems of the red variety shown in figure 1.

Successful growth of raspberries may depend even more on the type of subsoil than on the type of surface soil, and investigations have shown that subsoil types may vary considerably in some districts. Because of this fact, careful examination of the subsoil has an importance that cannot be too much emphasized. The most suitable subsoil is loose enough to permit good underdrainage and yet will retain considerable water. Michigan studies show that a high water table or hardpan dwarfs the plants and leads to early dying out.

The most important, perhaps, of all factors entering into the growing of raspberries is the moisture supply, and where there is possibility of a choice, the soil that will furnish an ample supply of moisture at all times should be chosen. At no time, however, should the water table be within 3 feet of the surface for a very long period. Thorough drainage, as well as a full supply of moisture, is essential.

Air drainage is also an important factor. Cold air settles to lower levels, and plantations situated on land elevated above the surrounding fields will be less subject to the extreme cold of winter than plantations on the lower levels. Winter injury to the canes may often be avoided by choosing a site higher than the surrounding country. Furthermore, plantations on the higher elevations are not so subject to frost injury in late spring as those not so favorably located.

Free air movement during the growing season tends to lower the humidity, which is very favorable to the growth of certain fungus diseases.

In the Southern States exposure is a fourth factor in the selection of a site and is of some importance. In those States a northern or northeastern slope is preferred for the raspberry plantation, as humus and moisture are retained better on such slopes than on southern slopes. For home gardens, the chicken yard is frequently a desirable place for the raspberry patch. Poultry keep down weeds and enrich the soil, and do not often injure the berries.

PREPARATION OF THE SOIL

Soil should be given the same thorough preparation for a raspberry plantation as for corn or similar crops. For the best results the plants should never be set in a field which has just been in sod, but should follow some crop, preferably a cultivated one. In many sections, especially in the Pacific Northwest, it is probably not advisable to plant black raspberries or some varieties of red raspberries following potatoes, tomatoes, or eggplants, because the fungi causing wilt diseases are often present in the soil following these crops and may attack raspberries.

The soil in which raspberries are to be planted should be thoroughly pulverized and in the best physical condition for holding moisture. Unless the soil is rich in organic matter, manure should be applied at the rate of 8 to 10 tons per acre, or a cover crop should be plowed under. It is much better to add organic matter before planting than later. Deep plowing, 6 to 8 inches or more, is necessary. Plowing may be done either in the fall or early spring, but in some sections of the country fall plowing gives better results. Thorough disking and harrowing just before planting will put the soil in good condition.

OBTAINING AND HANDLING THE STOCK

Plants of the different varieties of raspberries may be secured from any reliable nursery, and usually this is done in starting a new plantation.

Good nursery plants of the different types of raspberries are shown in figure 3. It must be remembered, however, that the root systems of nursery plants of the different varieties vary greatly, and what constitutes a good nursery plant of one variety may be a poor plant of another variety. Thus the Potomac, a purple variety, rarely makes as large a nursery plant as does the Columbian. Consequently a good nursery plant of the Potomac would not be considered a good plant of the Columbian.

It is possible to secure a good crop of berries from plants the year after they are set and a full crop the second year after planting. To do this, only the best grade of nursery stock should be ordered. If the plants are to be propagated at home, only the strongest tip plants of the black and purple sorts and the strongest suckers of red varieties should be selected. A good red raspberry plant for setting

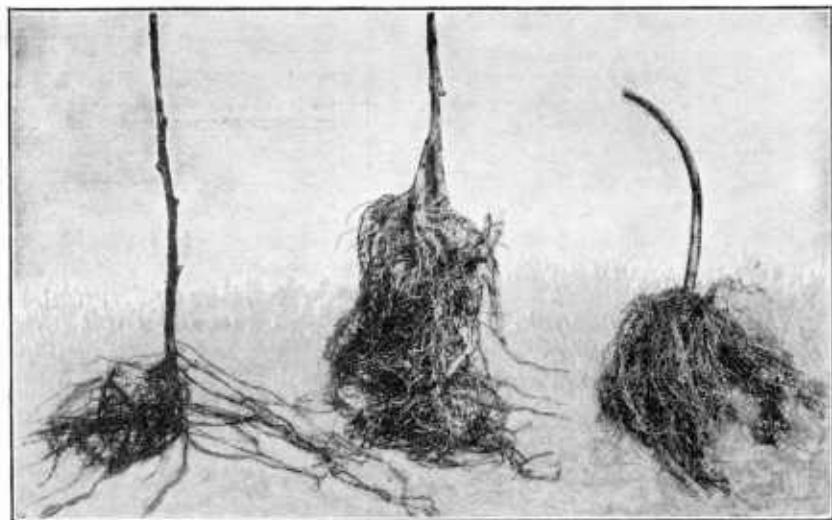


FIGURE 3.—Sample raspberry plants good for setting: Ranere (red) at the left, Columbian (purple) in the center, and Cumberland (black) at the right.

should have many small roots with several inches of the old root attached.

It is possible by selecting the best tip plants, planting them in fertile soil, and giving them good care, to secure more than 2,000 quarts per acre the year after setting and more than 4,000 quarts the following year from either red or black raspberries. The average production of raspberries is less than 1,000 quarts per acre.

Figure 4 shows a bundle of plants of the red raspberry as it was received from the nursery. In case the plants are not to be set immediately, they should be heeled in; that is, a trench should be dug and the roots placed in it and covered with moist soil. In order to work the soil thoroughly about the roots of each plant it will be necessary to open the bundles and spread the plants along the trench, as shown

in figure 5. Plants should not be allowed to dry out before being planted, but if they show signs of drying the roots should be wet, or if the plants are very dry, the roots should be soaked for a few hours before the plants are heeled in. Just before setting it is well to dip the roots of the plants in a puddle made of clay and water or cow manure and water. This partially protects the roots from the wind and sun.

Plants affected with crown gall should not be set. Moreover, many plants coming from fields in which the disease occurs may be affected without showing it, so that if only a few plants show galls when planted many may appear later. Crown gall can be recognized by the knots and swellings which appear on the roots and about the



FIGURE 4.—A bundle of 27 good plants of the Ranere raspberry as received from the nursery. When such plants cannot be set immediately, they should be "heeled in."



FIGURE 5.—Plants of the Cuthbert raspberry as received from the nursery, "heeled in" awaiting favorable opportunity to plant.

crown. Such diseased plants are very much less productive than healthy stock and are especially subject to winter injury.

Every possible precaution should be taken to prevent the introduction of virus and other serious diseases of raspberries in the nursery stock. Plants should be obtained only from carefully inspected and certified nurseries or plantations. Once these diseases are introduced, it is hard to control them without seriously reducing the profits.

PLANTING

The time of planting raspberries varies in different parts of the United States, according to local conditions. In general, the plants should be set in early spring in the eastern part of the United States, but on the Pacific coast they should be set during the rainy season, whenever it is possible to do the work.

Because better plants of the black and purple varieties can be secured in the spring, that is the best season for setting them. Red raspberries, however, may be set in the autumn with good success in sections where the winters are mild or where there is a good covering of snow to protect the plants. Some advantages of autumn planting in sections where this is possible are:

There is usually a much longer season of favorable planting conditions than in the spring.

During the winter the plants become thoroughly established in the soil and start growth quickly in the spring.

In the autumn the leader buds from which the new canes develop are dormant and are not easily broken. By spring, however, they have grown to a considerable length, often several inches, and then are very easily broken in planting. Unless the root is vigorous, such plants may not develop new shoots. Figure 6 shows the leader buds at the base of the cane in a dormant condition, and figure 7 shows the buds after they have developed into shoots several inches long, which are broken very easily.

In some districts, especially in the Pacific Northwest and in New Jersey, plantations are commonly started with so-called "green plants." A month or 6 weeks after growth begins in the spring the young green plants, or suckers, are transplanted during or following a period of rain. If the season is favorable this practice may prove satisfactory, though the field usually will take nearly a year longer to come into full bearing. If, however, a drought occurs soon after transplanting, the young plants will suffer severely. Only in sections where the climate is favorable is this practice recommended.

PLANTING DISTANCES UNDER VARIOUS SYSTEMS

Three systems of culture are used in growing raspberries, the hill, the linear, and the hedge systems. The term "hill system" is restricted to that method of tillage in which the horse cultivator is used on four sides of each plant. When the cultivator is run in only one direction and only the plants originally set are allowed to fruit, the term "linear system" is used. If some of the suckers which come from the roots of red raspberries are left to form a solid row and the cultivator is run in one direction only, the term "hedge system" is employed.

The distance between the rows in each system should be determined by the fertility, moisture supply, and type of soil and by economy in the cost of cultivation and in the use of land. Where the area of land available for planting is not limited it is usually desirable to make the rows far enough apart to allow the use of 2-horse implements in cultivation. Where the land area is limited, the rows may be placed closer together and 1-horse implements used.

Under the hill system of culture the plants are usually set about 5 feet apart each way, though varying from 3 by 6 to 8 by 8. The usual distance is 5 by 5 feet; this, however, allows the use of only

1-horse cultivators. Figures 8 and 9 show raspberries planted according to the hill system. This is used to some extent in New York, northern Michigan, Minnesota, and other States in raising red raspberries and in Maryland in raising black varieties. It has the advantage of requiring less hand work in keeping out grass and weeds, as

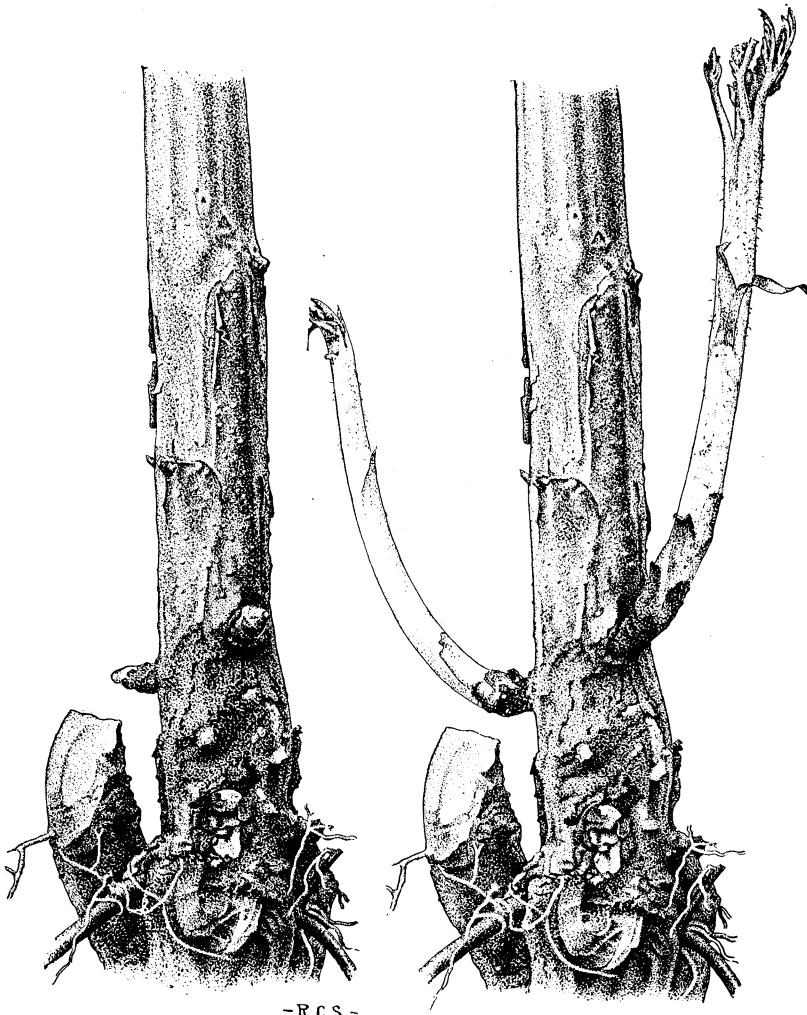


FIGURE 6.—Lower part of a raspberry cane, showing dormant leader buds from which strong vigorous shoots will grow in the early summer. (Drawing from a photograph taken February 9.)

FIGURE 7.—Lower part of the raspberry cane illustrated in figure 6, showing the new canes that have started growth from the leader buds. (Drawing from a photograph taken March 7.)

the cultivator can be run in both directions; also the berries can be more easily picked under this system.

If the hedge or linear system is used, the horse cultivator can be run in one direction only and more hand hoeing is necessary. Under

these systems the red varieties usually should be set from $1\frac{1}{2}$ to 3 feet apart in rows which are 6 to 8 feet distant. In the eastern United States 6 feet is the most common and desirable distance between the rows for the shorter caned varieties, such as the Marlboro, and 7 to 8 feet for the tall-caned varieties, like the Cuthbert and Latham. If two horses are to be used in a plantation the rows must be at least 8 feet apart. In the Pacific Northwest, where the canes grow very tall, the planting distance for red raspberries is usually $2\frac{1}{2}$ to 3 feet by 7 or 8 feet. In parts of Colorado and other States where irrigation and winter protection are necessary, the plants are usually set in rows which are 7 feet apart.

Black raspberries, except in Maryland, are nearly always grown



FIGURE 8.—Red raspberries 1 year old planted in accordance with the hill system.
(Photographed at Milton, N. Y., June 18.)

under the linear system and should be planted 3 or 4 feet apart in rows 6 or 7 feet apart.

The purple varieties also are grown under the linear system and should be planted 4 or 5 feet apart in rows which are separated by 7 or 8 feet. The Columbian and other purple varieties of equal vigor should be at least 5 feet apart in the row, but the Potomac may be set 4 feet apart.

If the plants are checked in both directions when set in accordance with either the hedge or linear system and are 3 or 4 feet apart in the row, it is possible to run a 1-horse cultivator both ways for the first year. This will save much work and reduce the first year's expense.

SETTING THE PLANTS

Before planting, the tops of plants of all types should be cut back to a height of 6 inches or less. To make it easy to handle the plants and to indicate the rows after setting, 4 to 6 inches of the cane are often left; but if 12 to 24 inches of canes are left new shoots may not start and the plants may die. To help control the anthracnose disease

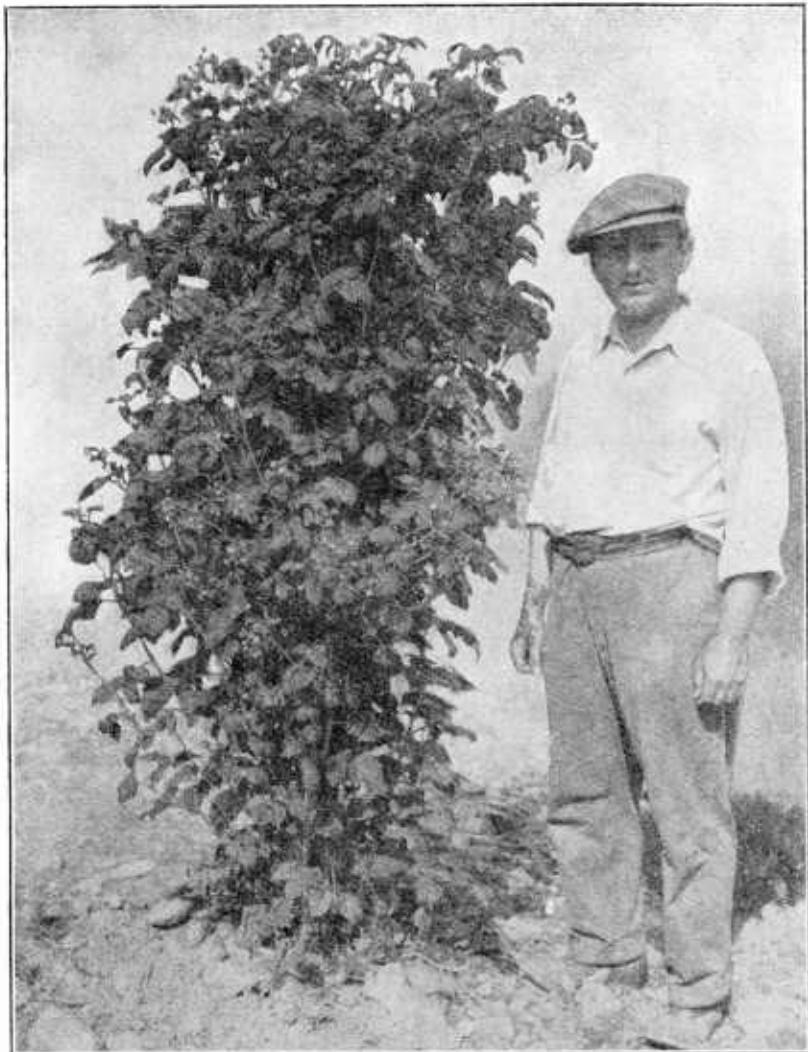


FIGURE 9.—A red raspberry bush planted in accordance with the hill system. This plant has seven bearing canes, which are tied to a single stake. (Photographed at Milton, N. Y., June 18.)

on black and purple sorts, it is recommended that all the cane be removed or entirely buried when the plants are set. By this means infection from old canes can be eliminated at the planting season. If

a garden patch is being planted, it is better to cut the canes back to within a few inches of the leader buds.

The plants should be set slightly deeper than they formerly grew. Sometimes in lighter soils it is well to set red raspberries as much as 3 inches deeper than they grew, in order to protect them from drought. Black and purple raspberry plants should be set not more than an inch or two deeper than they originally stood, as there is danger of smothering the tips.

Figures 10 and 11 illustrate a common and inexpensive method of setting the plants. The rows have been marked out previously, and plants have been dropped every 3 feet along the row. The spade is thrust into the ground, the handle pushed forward, and the root placed in the space thus opened, as shown in figure 10. The spade is next withdrawn and the earth firmed about the roots, as shown in figure 11. Plants should not be dropped much ahead of those who are setting them, however, as exposure to the sun and wind dries and kills the roots.



FIGURE 10.—Setting raspberries. The shovel or spade is thrust into the soil and forced forward. The plant is put in the opening thus made, and the shovel is then withdrawn. Earth is later firmed about the roots, as shown in figure 11. (Photographed at Putney, Vt., April 23.)



FIGURE 11.—Firming the earth about the roots of the raspberry plant shown in figure 10. In this field not more than 2 or 3 out of 10,000 plants set failed to grow. Figure 10 and the above illustration show a common and inexpensive method of setting raspberry plants.

CULTIVATION

MAINTENANCE OF MOISTURE SUPPLY

From the time raspberry plants are set, they need an ample supply of moisture, and they are affected more quickly and seriously when it is deficient than are most other fruit plants. Tests have indicated that the black raspberry loses moisture through its leaves more than twice as fast as the average of plants that have been

studied. The natural habitat of brambles is in partial shade where resistance to heavy evaporation is not necessary because of protection from taller vegetation. Man has greatly modified these natural conditions by moving brambles into open fields. This fact probably explains winter or spring injury to brambles. Full sunlight starts them too early and they suffer.

The fact that yields of raspberries range from 7,000 quarts to the acre in some sections to an average of less than 1,000 quarts an acre for the whole country is largely due to differences in the moisture supply in the various sections. In the sections giving the highest yields, a deep soil furnishes a uniform and ample supply of moisture at all times. To secure the best results, therefore, the grower, by tillage and by supplying humus, should maintain a uniform and ample moisture content in his soil, not only during the growing and ripening of the fruit but also while the canes are developing. Some growers make it a regular practice each year to mulch their fields to a depth of several inches with straw, leaves, or green hay. The cost of this practice is heavy, but the moisture supply is well retained, and the soil temperature is much more uniform. In a test in Maryland where the plants were not growing well the mulched plants gave a yield of five times that of the unmulched.

In semiarid and arid regions where irrigation is practiced, the fruiting season is longer than in most humid or nonirrigated sections. The use of irrigation in the Eastern States also has extended the picking season and made the plants thriftier. Larger yields of fruit of the Ranere raspberry in the summer and fall have followed irrigation of that variety and have made the practice profitable in some sections of the East.

In the semiarid and arid regions of the Pacific coast, irrigation should begin almost as soon after the rainy season as is necessary for garden crops and should be continued at least until after the picking season is over. The frequency of irrigation will depend upon the local climate, the soil type, and the management of the soil. In southern California the plantation should be irrigated as often as every week during the fruiting season and about once in 2 or 3 weeks during the rest of the dry season. Cultivation should follow each application of water. When this is done the irrigation need not be so frequent, and the soil will be kept in better condition than without such tillage. Under such treatment the Surprise red raspberry will, in some parts of California, not only produce a good second crop of fruit during the late summer or early fall but will also produce some fruit almost continuously from the first picking in the spring until late autumn. In arid and semiarid sections other than California such frequent irrigation is not often used; its frequency is determined by local conditions.

In the humid sections of the Eastern States irrigation should be practiced chiefly or entirely during the growth and ripening of the fruit and will pay only when an ample moisture supply cannot be maintained by tillage. Since the raspberry ripens its crop during the summer when droughts are likely to occur, some growers have found irrigation profitable. In one test in Michigan an increased yield of about 1,000 quarts per acre was obtained by irrigation during a dry season.

INTERCROPPING

In order to reduce the cost of intensive cultivation of a raspberry plantation during the first year after setting, other crops that need cultivation during the spring and early summer months may be grown between the rows. Among the crops best suited to this purpose are the tomato, cabbage, cauliflower, bean, pea, summer squash, and potato. Grain crops should not be used, as they are not cultivated and will take moisture and plant food needed by the raspberry plants. The second season no other crops should be grown, as the raspberry roots should occupy all the ground. The potato should not be grown with black varieties or with those red sorts subject to wilt disease.

TILLAGE

Tillage in raspberry fields must be thorough and more regular than for most other crops. If grass and weeds get a start, it is very difficult to clean the rows. Not only will it prove costly to clean them, but grass and weeds take the needed moisture and interfere with the development of new canes. If grass is allowed to make a sod in a field trained to the wide hedge system, it is usually cheaper to set out a new field than to clean out the sod. Plowing in early spring is a common practice with many of the best growers. At the centers between the rows it may be 6 to 8 inches deep, but it should be only 3 to 4 inches next to the plants. In the Pacific Northwest, if no cover crop is used, plowing toward the rows in February and away from them in April is customary.

Except in rainy weather, a cultivator or harrow should be used frequently up to picking time. Some growers consider it profitable to use it as often as once each week, and this is sometimes necessary for weed control. The cultivation should stir the soil to a depth of 2 to 3 inches only, as part of the raspberry roots are shallow. Deep tillage may cause serious injury unless it has been practiced from the time the plantation was set. Many growers shorten the cultivator or harrow teeth which run next to the plants in order to disturb the young feeding roots near the surface as little as possible.

During the harvesting season the berries need an additional supply of moisture, and ordinarily the cultivation should be continued. Many growers cultivate after each picking, loosening the soil packed down by the pickers. If too much dust is carried to the fruit it may be necessary to cultivate only occasionally during the picking season. Also if no trellis or stakes are used and if the canes bend over under a crop of fruit it will be impossible to use a cultivator without knocking off too much fruit.

Later tillage is for the purpose of keeping down weeds and grasses. Autumn tillage, however, tends to develop new growth, which is tender and somewhat more subject to winter injury than the older growth. Autumn tillage, therefore, should be avoided as much as possible where there is danger from severe winters.

SUMMER THINNING

In the red-raspberry section of western Washington most of the best growers thin the new canes when the second hoeing is done

in early summer. At that time a large part of the surplus canes are easily removed before they have grown large. This practice conserves the plant vigor and makes picking easier. Additional canes are often removed just before picking. Black-raspberry canes are not often thinned at this time because of the cost. However, a few expert black-raspberry growers in Oregon thin the new canes before the picking season.

MAINTENANCE OF FERTILITY

The use of fertilizers in raspberry plantations is governed by the same principles that apply to their use with other fruits. As soils vary in the quantity and availability of the plant food they contain, the fertilizer problem is a local one which each grower must solve for himself. By using varying amounts of the different elements of plant food on different plots and keeping a record of the yields, each grower can determine readily what kinds and quantities of fertilizer to apply.

Good management, however, will insure a large amount of humus in the soil at all times. It is especially desirable that the humus supply be ample when the plantation is first set out. It is much easier and cheaper to furnish the humus by means of cover crops and stable manure before the plantation is set than afterwards when the plants are growing. Moreover, by such extra care before setting it is possible to secure a fair crop of fruit the second season. Because it costs so much to care for a plantation for a year it will pay well to have the soil in a high state of fertility before the plants are set, so that the plantation may be brought into bearing a year sooner than would be possible otherwise. Whenever possible, barnyard manure should be used before a plantation is set. If manure is not available, one or two cover crops should be plowed under. Many western growers now seed oats or barley with vetch and allow them to mature and reseed. Then the thick new growth is plowed under before raspberries are planted.

A distinction in fertility requirements should be made between the red and black varieties. Apparently, no soil is too fertile for satisfactory results with the black raspberry, and the richer the soil the stronger the growth and the greater the crop. The red raspberry should be grown on a fertile soil, but the relation of fertilizers to crop production in red varieties is not well understood. However, in the Pacific Northwest, fertile river-bottom soils are among the most productive, and the yields obtained by growers using good cultural practices vary from 1 to 6 tons of berries per acre. Apparently these variations in results are chiefly due to the differences in fertility and moisture supply of the soil.

Studies made in Michigan showed that the canes with greatest diameters were much more productive than those with smaller, while red-raspberry canes, so vigorous that they branched, produced much more fruit than the unbranched ones. Though the best results may not come from using applications of fertilizer as heavy for the red as for the black raspberry, the best yields of red raspberries in the United States are from fields where annual applications of

2 to 15 tons of stable manure and 400 to 500 pounds of fertilizer are made. Purple varieties seem to respond somewhat as do the black raspberries.

In many sections no fertilizers are used on bearing plantations. In the older raspberry sections, however, some commercial fertilizer and stable manure are used, and it is considered profitable to apply them. Stable manure, however, usually has given the best results and experiments have shown that, where obtainable, it furnishes the best means of enriching the soils on which the experiments have been tried. Stable manure not only furnishes plant food but supplies large quantities of humus. If an annual application of about 10 tons per acre is made, the humus supply should be maintained, and with proper treatment in other ways the field should be kept in a high state of productiveness. Some soils and some sections will need more and some less than 10 tons per acre. A heavier application should not be made unless it has been found by actual trial to be desirable, as it is possible to stimulate the growth of canes and leaves to such an extent as to reduce productiveness.

Experiments indicate that the average composition of stable manure is low in phosphorus and a little low in nitrogen. It is therefore suggested that growers try the addition of 100 pounds of nitrate of soda and 400 pounds of superphosphate per acre in addition to 10 tons of stable manure. Poultry manure is richer in nitrogen, and growers have had good results from light applications of strawy litter.

If stable manure is not available, an application of about 200 pounds of nitrate of soda per acre to black-raspberry fields at blossoming time is suggested. In one test in Oregon red raspberries also gave increased yields following an application of 250 pounds of nitrate of soda alone, just as growth started in the spring.

Cover crops may be used to maintain the humus supply in fields where the cane growth is not too rank. Oats seeded at the rate of 3 bushels per acre in the late summer should give a dense stand of material to turn under before winter, or they may be left to serve as a covering during the winter and plowed under in the spring. Cow-peas, millet, vetch, the various clovers, and other crops may also be used in the raspberry plantation. Care must be taken in sowing winter oats, vetch, and clovers, as they live through the winter in many sections. If they are drilled in between the rows and turned under before they become too rank in the spring, little trouble should be experienced. Plowing toward the row not later than April 1 in the Northwest and away from the rows 2 weeks later should serve to kill them.

TRAINING AND PRUNING

The best system of training and pruning different types of raspberries depends largely upon their manner of growth. All types send up shoots from the leader buds which usually are formed at the base of the old canes, as shown in figures 6 and 7. Sometimes only one such bud is produced on each cane, but usually at least two are formed, and sometimes three or more appear. Thus, if two canes grew the first year after planting and each produced two buds, four

canes would appear the second year, eight canes would be formed the third year, and by the fourth year there would be 16. However, some of the buds do not start and many of those that do start make weak canes, so that when plants are in bearing, about the same number of strong canes are produced the first year after the plantation comes into full bearing as during each of the following years.

The new shoots of all types of raspberries complete their development in size the first season. During the second season small side branches are sent out and on these the fruit is borne. Soon after the berries ripen the cane dies. Thus the canes are biennial—that is, they live for part of 2 years; and the roots are perennial, living for many years. A few varieties of red raspberries, among which is the Ranere, bear fruit on the tips of the new canes in the summer and autumn of their first year of growth. Such tips die back, and

the parts of the cane which have not fruited bear the following summer.

In addition to producing canes from the leader buds, red raspberries send up shoots called "suckers" from their roots (fig. 12), but the black and purple varieties do not send up suckers. Some varieties of red raspberries produce suckers in large numbers; others produce few. Deep plowing or cultivating may cut the roots of the red raspberry and cause an increase in the production of suckers. Therefore, if some system of training

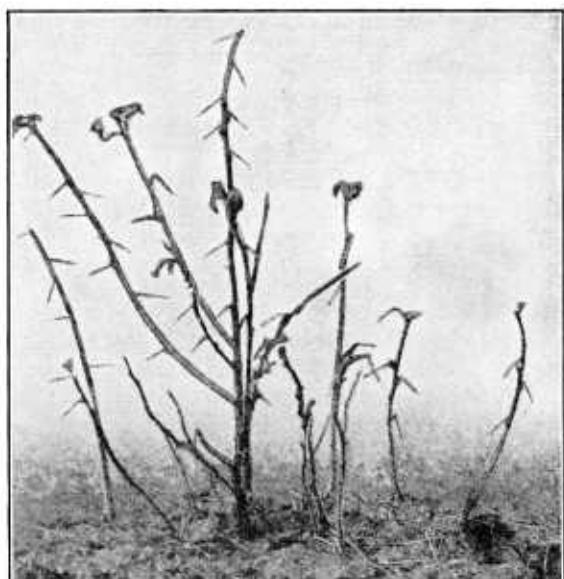


FIGURE 12.—A Ruby red-raspberry plant having two strong canes which grow from leader buds and with a large number of suckers springing from the roots.

were not used a red-raspberry field would soon become a dense thicket of canes, each competing with others for food, moisture, and light, and the berries could be picked only with difficulty. Therefore, the methods of pruning and training red raspberries differ from those employed with the black and purple types and are described separately.

The system of training and pruning varies not only with the type of raspberry but also with the vigor and nature of the variety, with climatic conditions, with the cost of materials, and with the preference of the grower. Thus, the Ranere red raspberry produces numerous comparatively slender canes, while others, like the Marlboro and Chief, make fewer canes, which are much stouter and more erect. The Ranere is not a tall-growing variety, but the Cuthbert canes grow

very tall. Varieties of the black and purple types do not show such great differences in growth as do the red sorts. Nevertheless the training and pruning system to be used with these types also will depend to a large extent upon the habit of the variety.

Under the conditions which are found in New England, canes of the Marlboro red raspberry usually grow from 3 to 5 feet high, yet in Washington and Oregon they may even grow to a height of over 10 feet. Similar differences occur when other varieties are grown in such sections, and this makes necessary training and pruning systems especially adapted to local conditions.

Reference to the figures illustrating the principal methods will indicate how different is the growth of plants in different sections and how numerous are the systems of training. Many variations and modifications of each are used, but only the principal ones will be described.

TIME OF PRUNING

All the old canes of red, black, and purple raspberries should be cut out immediately after fruiting. By doing this diseases on the canes and leaves are removed, moisture that might be lost through the leaves is conserved, and the new shoots get more room and light. Cutting out the canes late in the summer or fall is not advisable, because the new shoots may not harden sufficiently to withstand winter cold and may break over with heavy snows. If the young shoots of black and purple raspberries are to be pinched back to induce branching, this should be done early in the summer when the shoots are 12 to 36 inches high, as discussed on page 25. All additional pruning should be done in early spring while the plant is still dormant but after danger of later cold injury has passed.

RED RASPBERRIES

Three methods of culture of red raspberries are in use—the hill, the linear, and the hedge systems. As the planting plan of each is different, the system to be used must be determined before the plantation is set.

THE HILL SYSTEM

Under the hill system the plants should be set about 5 feet apart each way. A stake $1\frac{1}{2}$ to 4 inches in diameter should be driven into the ground beside each plant when it is 1 year old and the canes tied twice to each stake, once about half way up and again at the top of the stake. About seven of the strongest canes should be left to each plant, the others being cut out. Where as few as five canes are left under eastern conditions the yields may be distinctly less than where eight canes are left. Ordinarily the tips are not pruned back. In Minnesota, however, the canes are topped at about 5 feet. Figures 8 and 9 show examples of a tall-growing red raspberry grown under this system. The stakes in this case extend about 6 feet above the ground. Other varieties have shorter canes, and the stakes should correspond to the height of the canes. Varieties like the Marlboro and Latham may be grown under this system more easily than those which make a rank growth of suckers, as does Ranere.

This system is used in New York and Minnesota extensively and is to be recommended for sections having similar conditions. Slightly greater yields under the hedge and linear systems may be more than offset by the lower tillage costs and the ease of harvesting under the hill system. To secure the advantage of this system, however, it should be possible to cultivate in both directions with comparative ease, and it should also be possible to secure stakes at a reasonable cost.

THE HEDGE SYSTEM

Where the canes are stout and from 3 to 5 feet tall, growers in the Eastern States often allow a solid row or hedge 2 to 3 feet wide to form, as shown in figure 13. This system is the most common one in the eastern United States and is adapted to such short-caned varieties as the King, Marlboro, Herbert, and Latham. A modifi-

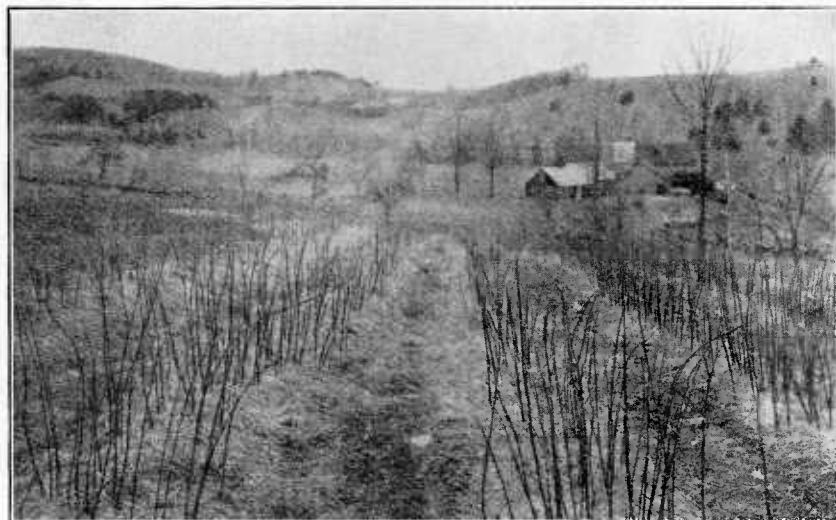


FIGURE 13.—Red raspberries at Putney, Vt., planted in accordance with the hedge system and mulched with straw. The rows are too wide for the best results.

cation of this system is used extensively in New Jersey in growing Ranere. The canes of the Ranere are comparatively slender, and in early spring growers cut the tops back with hedge shears so that they can support the crop in an erect position. Sometimes the Cuthbert also is grown under this system, as shown in figure 14.

The hedge system is modified further in some sections where the canes grow taller or are not stout enough to hold the fruit in an erect position. Under such conditions a "horizontal trellis" is made when the plantation is 1 year old by stringing two wires along each end of crosspieces which are attached to posts set every 15 to 30 feet in the rows. The wires support the canes, so that they are not broken by pickers or in cultivating. No pruning back is usually done. However, in Michigan tests have shown that a light heading back of the Cuthbert variety in the spring resulted in increased yields and easier

picking. Severe heading decreased yields and made harvesting more difficult.

This system is used somewhat in New York, in California, and in other States. A slight modification of it is used in the irrigated sections of eastern Colorado, where the canes are buried in the winter for protection against the cold. In this region posts are set only at the ends of the rows, as illustrated in figure 15. The wires which hold the canes erect are held in place by wooden supports, as shown in figure 16. These supports hold the wires about 2 feet high and $1\frac{1}{2}$ feet apart and can be taken down at any time, so that the wires will drop to the ground and thus be out of the way.

This system, called the wide hedge system, has serious disadvantages. When the row is from 2 to 3 feet wide it is difficult to get the



FIGURE 14.—A field of Cuthbert red raspberries planted in accordance with the hedge system. The canes are pruned back in the spring, so that they will support the crop of fruit. (Photographed at Webster, N. Y., in July.)

berries picked; there always are some weak canes which bend over so that the fruit becomes dirty; there is such competition between the canes for moisture and light that the fruit is smaller than it otherwise would be; and unless the rows are separated more than 8 feet a 2-horse cultivator cannot be used. Perhaps the most serious disadvantage of this system is that it is very difficult and expensive to keep such fields free from grass and weeds.

For most sections the best form of the hedge system is that called the narrow-hedge system, illustrated in figure 17. Suckers are allowed to grow up only in the rows between the plants originally set, and

all others are kept out. The rows then will be about 12 inches wide, and a large part of the tillage can be done with a cultivator. Wire trellises are used with this, as with the wide-hedge system, when the canes are very tall or very weak. Light heading back in the spring should be done. Studies in Michigan showed that 10 canes per 4 lineal feet of row gave greater yields than where greater thinning was practiced.

For much of the eastern United States this narrow-hedge system is one of the most desirable; it should be adopted by growers in place of the wide-hedge system unless the hill or linear systems can be used.

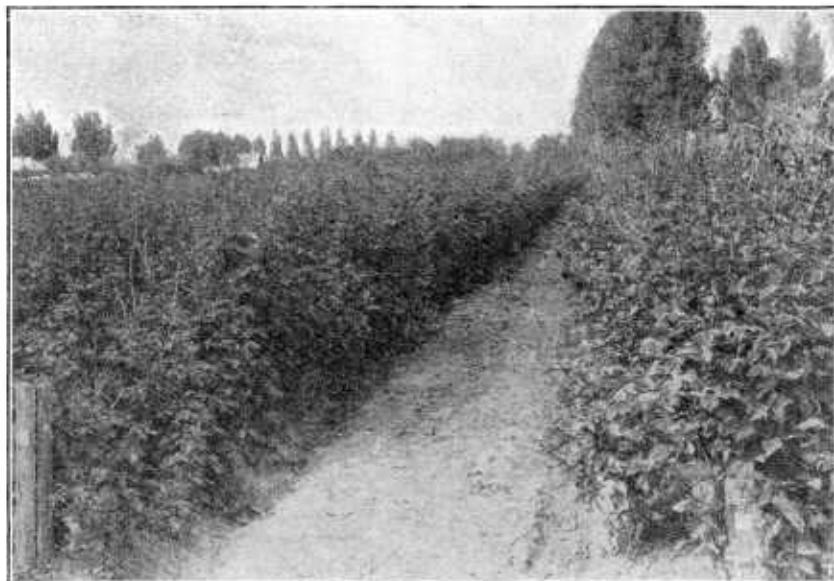


FIGURE 15.—A field of Marlboro red raspberries planted in accordance with the hedge system of culture. The canes are held erect by a 2-wire horizontal trellis. Note the irrigation ditches. (Photographed at Loveland, Colo., July 22.)

THE LINEAR SYSTEM

The linear system, which differs from the hedge system in that no suckers are allowed to grow, seems to be becoming more popular and is to be preferred to any other in some sections. It is used very commonly in all parts of the United States in training varieties which have strong, erect canes, and it is the only system used to any extent in the State of Washington. The simplest form of this system is that used where the canes are stout and short and will hold an erect position when bearing a full crop of fruit. All sucker plants should be removed and the plants originally set kept for fruit bearing. Most of the cultivating can be done with the horse cultivator and horse hoe, and comparatively little handwork is necessary. The tall-caned varieties are somewhat headed back until the canes are self-supporting where grown under this system.

In Oregon and Washington, where the tall-caned Cuthbert is grown and where the canes of many of the other varieties grow very tall, some means of supporting the canes is used. The two most common practices are shown in figure 18. There is little difference in time required to train the canes by either system. To the left the canes are pruned or topped to a height of about $5\frac{1}{2}$ feet and are held erect by a horizontal 2-wire trellis, such as is used in the hedge system. Two wires about 5 feet above the ground, one on each side of the row, hold the canes erect. To make picking more convenient, and to prevent injury to the buds by wind whipping, the canes are often tied to the wires on either side, and the new canes are allowed to grow up between the wires, as illustrated in figure 19. Thus the fruiting canes are separated from the new ones. Figure 20 shows a simple method of tying each cane separately with one string. A hard knot should be made every few feet, so that if the string breaks the damage may not be extensive. Where some provision is needed to keep the new canes out of the way of pickers and cultivators, one or two additional wires are strung along just before picking. Some growers in the Eastern States use another form of wire trellis, where all the fruiting canes are tied to a single wire, as in figure 21, or, when very tall, to two wires, one above the other, to hold them erect. The tying is inexpensive and is easily done by children.

Though topping at $5\frac{1}{2}$ feet and tying to wires is a common practice in the Northwest, and some of the highest yields have thus been obtained, a second system of training is almost as common. Under

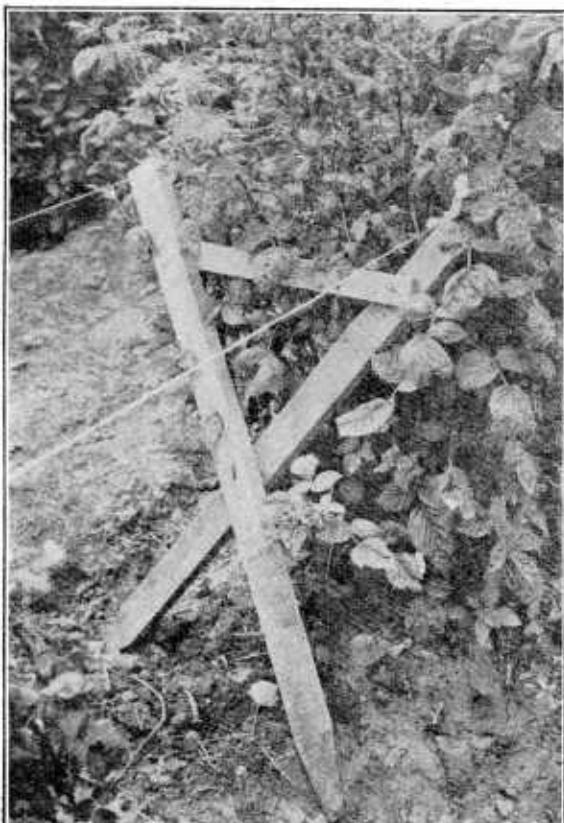


FIGURE 16.—A wooden support used in raspberry fields where two wires hold the bearing and young canes upright. A bent nail keeps the wires from slipping below the desired height.

this method, as shown at the right in figure 18, the canes are arched over a single wire and caught under the canes of the next hill. The ends are then woven along the wire and among the canes, or are topped

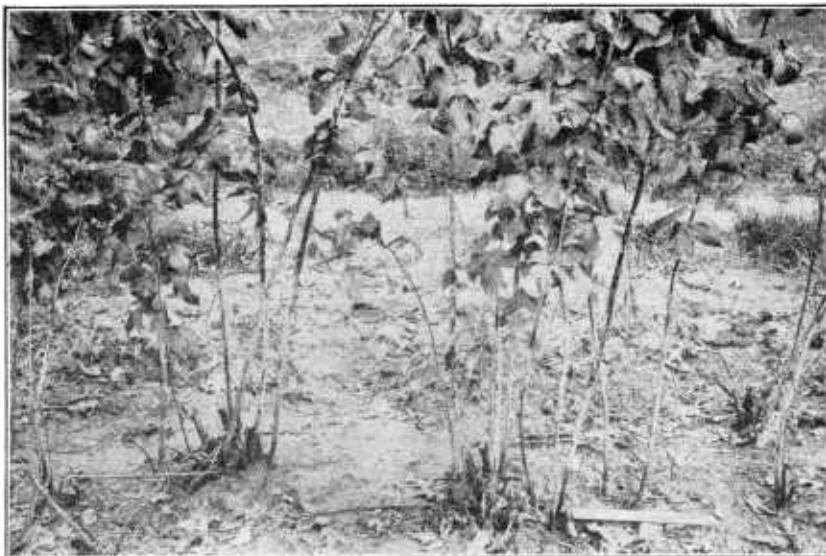


FIGURE 17.—Red raspberries planted in accordance with the narrow hedge system of culture. The canes are kept in a row about 12 inches wide and are well spaced in the row. (Photographed at Excelsior, Minn., September 26.)



FIGURE 18.—A field of Cuthbert raspberries under the linear system of culture. At the left, two wires, one on either side, hold the canes erect. The wires are about 5 feet above the ground, and the canes are topped about 5 1/2 feet from the ground, which in general has been found the best height where the canes grow tall. At the right the canes are woven to one wire, but the canes average about 6 1/2 feet long. (Photographed at Sumner, Wash., February 20.)

as shown in figure 22, at a length of about $6\frac{1}{2}$ feet. In order to distribute the fruiting space more uniformly it is better to weave each cane separately, or not more than four canes at a time, than to have all the canes of a hill woven together. Under this system one or two additional wires are also used to hold the young canes erect.

Where the canes do not grow so tall as those shown they may be

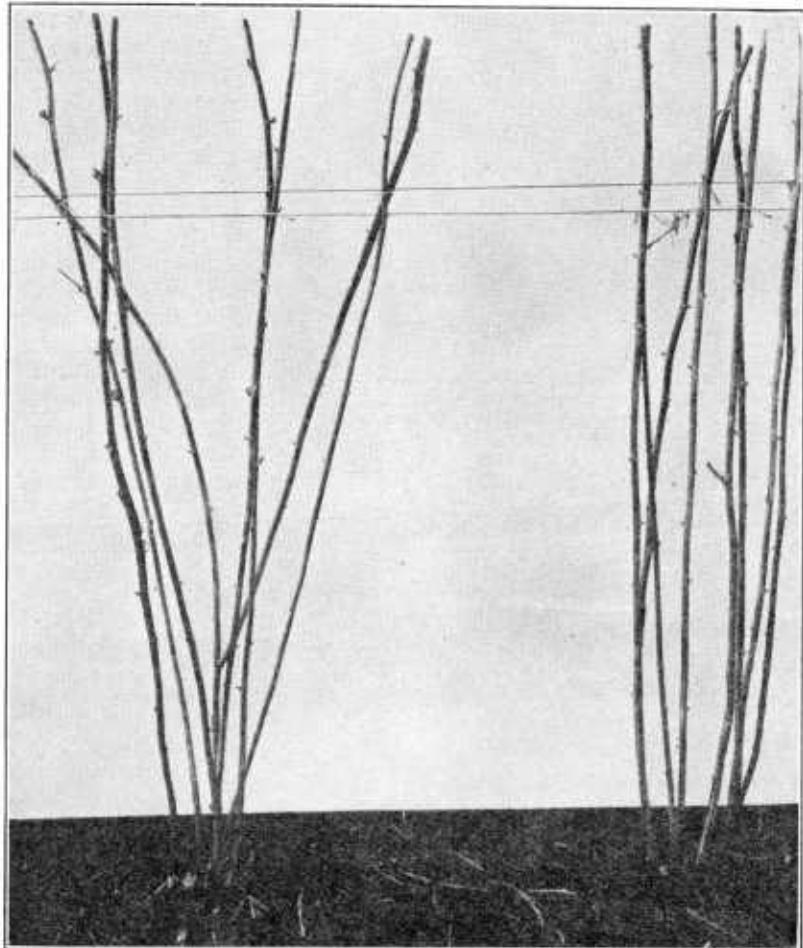


FIGURE 19.—Cuthbert raspberries planted on the linear system of culture. The fruiting canes are tied to wires about 5 feet high on either side, and the young canes grow up between the fruiting canes. Topping should be practiced at $5\frac{1}{2}$ feet as shown, in order to bring the fruit within reach. (Photographed at Sumner, Wash., February 20.)

topped at a height of 4 or 5 feet and the trellis built lower. Topping is usually done in the spring just before growth starts.

Many modifications of the systems described are in use and are adapted to particular conditions. The linear system, where only the original plants are kept for fruiting, or the narrow hedge system,

where the original plants and a very few suckers well distributed between them are retained, are generally the best. The life of the plantation under these systems is much longer, it is easier to conserve moisture in times of drought, and the picking is easier than in plantations trained to the wide hedge system.

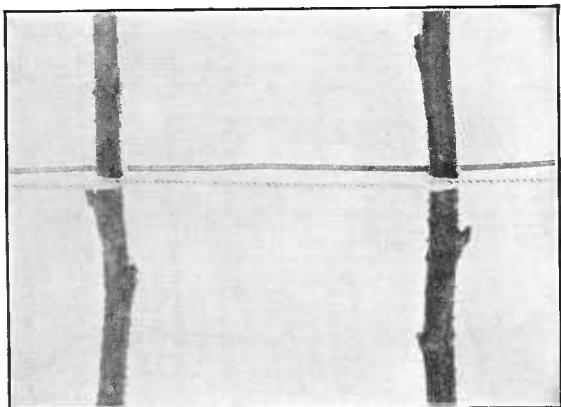


FIGURE 20.—Raspberry canes tied to a wire trellis. Canes can be tied very rapidly when this system is used, and the cost per acre is small.

The hill system is adapted only to localities where varieties that produce comparatively few canes are raised, where stakes are cheap, and where cultivators can be run easily in both directions.

Where the canes may not be entirely hardy, experiments in Missouri indicate that the removal of the first shoots appearing in the spring resulted in the growth of much harder shoots later. This practice has been used commercially in Connecticut for many years.

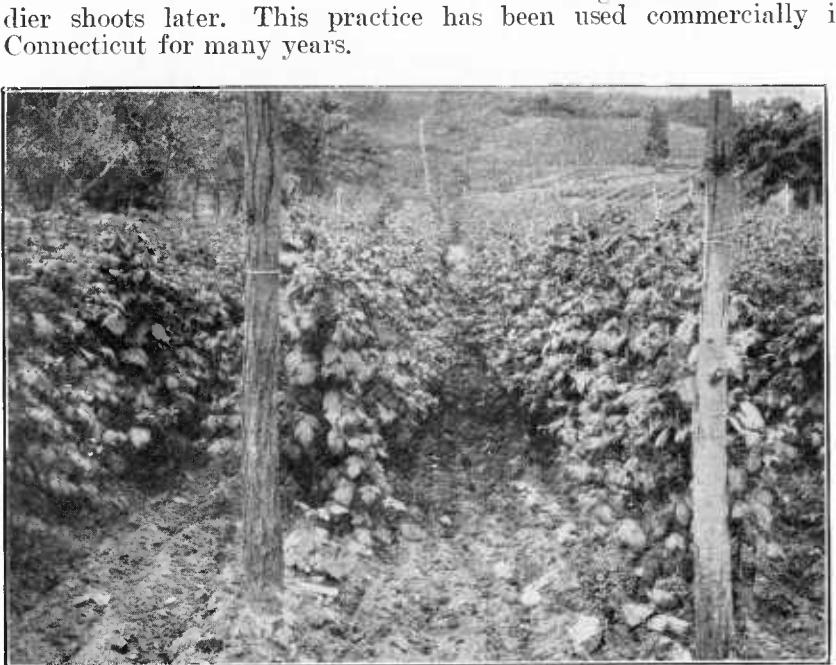


FIGURE 21.—A field of 1-year-old red raspberries trained to a single-wire trellis under the linear system. The bearing canes are tied to the wire to hold them erect. (Photographed at Marlboro, N. Y., June 23.)

BLACK AND PURPLE RASPBERRIES

The black and purple raspberries are nearly always planted on the linear system, and, as they do not send up suckers from their roots, their training is much simpler than that of the red raspberry. The young canes should be topped in order to enable them to stand erect when bearing a heavy crop of fruit. Black raspberries should be topped at a height of 12 to 30 inches, depending on their vigor, 18 inches being the most common height. Purple raspberries should be topped at a height of 30 to 36 inches, as their growth is more vigorous. The topping may consist in cutting off the ends of the canes after all have reached the desired height, and usually it is done just before picking.

Topping also may be done by pinching off with the fingers the ends of the young canes as soon as they reach the proper height. In

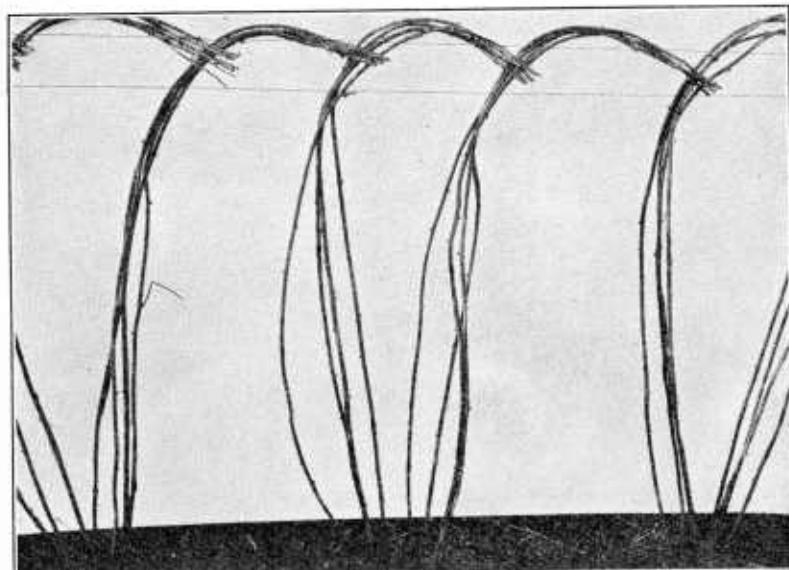


FIGURE 22.—Red raspberries planted on the linear system and trained to a wire trellis. The canes are arched over a single wire and caught under the canes of the next hill. As shown, half of the canes of each hill are woven separately to spread them apart. The projecting ends are cut off. Two additional wires are used to hold the new canes erect. (Photographed at Sumner, Wash., February 20.)

this case it will be necessary to go over the plantation several times, as the new canes do not all reach this height at the same time. Pinching the tips should be preferred to cutting the ends wherever diseases are likely to enter the cuts and kill back the canes.

Side branches called laterals grow from the buds along the cane which has been pinched or pruned back. These laterals grow to a length of several feet by late summer. In early spring, before growth starts, they should be shortened according to the vigor of the plant and the habit of the variety. The fruit is borne on the growth of the current season which starts from the well-developed buds on

the laterals, and the number and size of the berries can be controlled by the number of buds left on them in the pruning. Varieties differ in the location of the buds and should be pruned accordingly. Sometimes the buds start very near the base of the lateral, next to the main stem, and sometimes at a distance from the base. The laterals in the former case should be pruned shorter than if the buds are borne at a distance from the base.

Investigations in Michigan show that where the canes are small the laterals should have not more than 2 buds each, while the largest canes can carry as many as 8 to 12 buds to each lateral. If more buds are left on each lateral, more berries will mature, but they will be smaller and of poorer market grade than if only 2 to 6 buds had been left. Moreover, the total crop from those with the



FIGURE 23.—Columbian purple raspberries planted in accordance with the linear system. By careful pruning each plant is made to support its crop of fruit. The canes were topped 2 feet high and the laterals pruned back to 18 or 20 inches. (Photographed at Webster, N. Y., July 15.)

small number of buds per lateral will be equal to or greater than that from plants with the longer laterals. The cost of picking will be less and the berries will be of higher grade than from bushes with the greater number of buds to the lateral. In the Eastern States canes pruned in this manner are not ordinarily supported. In Oregon a 2-wire trellis about 3 feet high is commonly used to support the canes. Sometimes the canes are tied loosely together for support instead of to wires. Rarely they are tied to stakes set at each

plant. Figure 23 shows a field of purple raspberries trained to the system described above, and figures 24 and 25 illustrate the method of pruning both black and purple types.

Occasionally the canes of black raspberries are topped at a height of $3\frac{1}{2}$ to 4 feet and a 1-wire trellis or a horizontal trellis with a wire on each side of the row is used to hold the canes erect. In some few cases they are not topped but are trained to trellises, as described for training red raspberries. Rarely, however, are the purple varieties trained under any system other than that which includes topping at a height of $2\frac{1}{2}$ to 3 feet and pruning back the laterals in the spring. The expense of such a system is less than where a trellis is used, and under ordinary conditions the maximum amount of fruit of both black and purple raspberries will be secured from this system at a minimum cost.

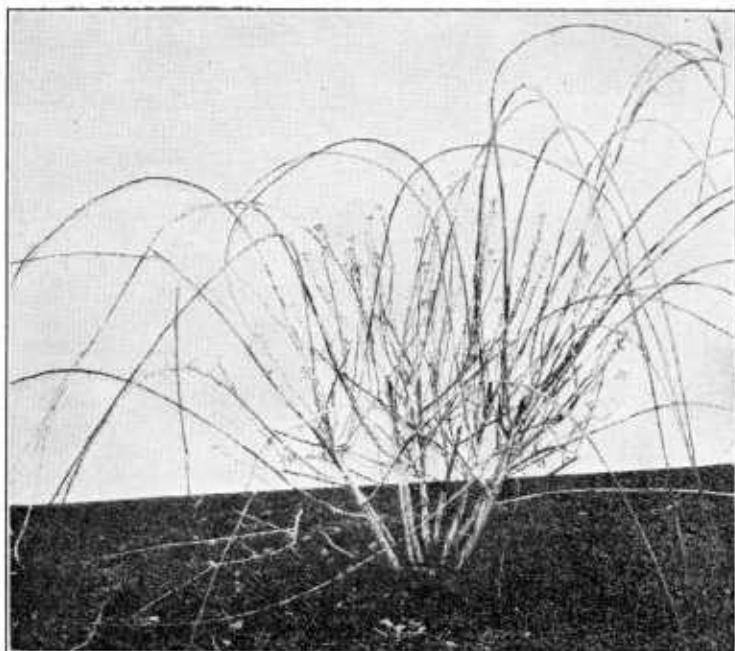


FIGURE 24.—A black-raspberry plant before removal of old canes, thinning, or pruning, showing laterals rooting at the tip. (See fig. 25.)

REMOVING OLD CANES AND THINNING NEW

In the Eastern States the old canes are often removed as soon as the crop is harvested. In Oregon and Washington they are usually not cut out until the beginning of cold weather and sometimes not until early spring.

At the same time that the old canes are cut out the young canes and suckers should be thinned. Where red raspberries are kept in hills, all suckers and all weak new shoots should be removed. Ordinarily about 7 strong, vigorous canes should be left, but as high as 8 or 9 canes may be safely left in vigorous hills where the plants are

set 5 feet apart each way. In the irrigated sections of Colorado, however, it is considered best to leave 8 to 12 canes per hill of the Marlboro variety. The Ranere in New Jersey makes a large number of small canes, and as many as 10 or 12 may be left in each hill. Sometimes, in order to secure a large crop on the new canes of the Ranere in late summer, all canes are cut off at the ground in early spring, and the strength required to mature an early crop is forced into cane production.

Investigations in Michigan indicate that in order to secure maximum crops all the strong canes (over one-half inch in diameter) of the black and purple raspberries should be left. Most plants of black varieties will average 4 to 5 strong canes each, though fields with an average of over 15 canes over one-half inch in diameter have been seen. Strong plants can support all the canes over one-half inch in diameter if the laterals are closely pruned. Weak plants may not be capable of carrying more than two canes.

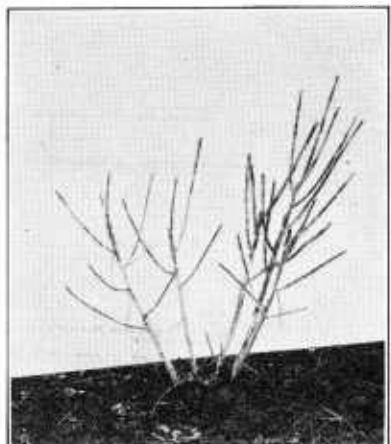


FIGURE 25.—The black-raspberry plant shown in figure 24 after removing the old canes and pruning, leaving each lateral branch 6 to 8 inches long. Such plants, where the canes are more than one-half inch in diameter and the laterals are pruned back heavily, bear maximum crops of large berries.

shears of various types are most often used in cutting out old canes and in pruning red raspberries. In New Jersey, where the Ranere is grown extensively, hedge shears are used to cut off the ends of the young canes which have fruited and to prune the canes back to the proper height.

PRUNING FOR LATE FRUIT

In order to extend the season of red raspberries for the home table, the canes may be cut back to within about a foot of the ground in the autumn or in early spring. The strength of the plant then will go into the lower buds and a long shoot will be made before the flowers appear. The fruiting season may be extended from 2 to 4 weeks by this practice, but the crop will be reduced considerably.

When the hedge system is used with the red varieties the canes should be thinned so that they are not closer together than 8 inches. When several canes appear from the same crown, the more vigorous ones should be left. Figure 17 shows proper thinning under this system. Figures 18, 19, and 22 show plants under the linear system in which the canes have been thinned properly, and figures 8, 9, and 26 show red raspberries under the hill system with canes thinned correctly.

Different types of cane cutters sometimes used for removing the old canes of black raspberries are shown in figure 27. When the blade is kept sharp and a quick pull is given in cutting, such a tool is very satisfactory. Pruning

WINTER PROTECTION

Experiments in Missouri indicate that removal of the first shoots to appear in the spring resulted in the growth of later canes that were much hardier. Other experiments in the same State showed that a late-summer cover crop of oats (3 bushels per acre) with an early fall application of nitrate of soda (225 pounds per acre) resulted in the highest degree of hardiness. How widely this practice will prove effective is not known.

In many parts of Colorado and in some of the western North-Central States raspberry canes must be protected from the cold, drying winds of winter. Usually soil is used for this purpose and is more satisfactory than straw or similar material. The canes are

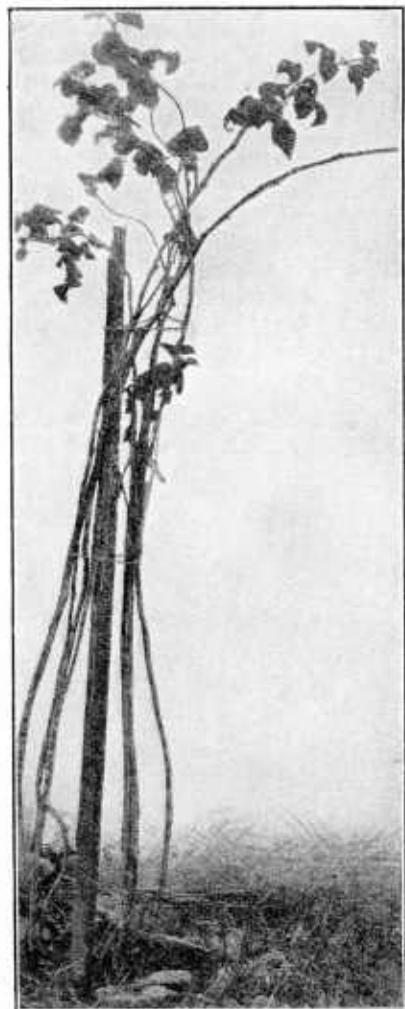


FIGURE 26.—A plant of Perfection red raspberry grown in accordance with the hill system, the canes being trained to stakes. Seven canes have been left for fruiting. (Photographed at Milton, N. Y.)

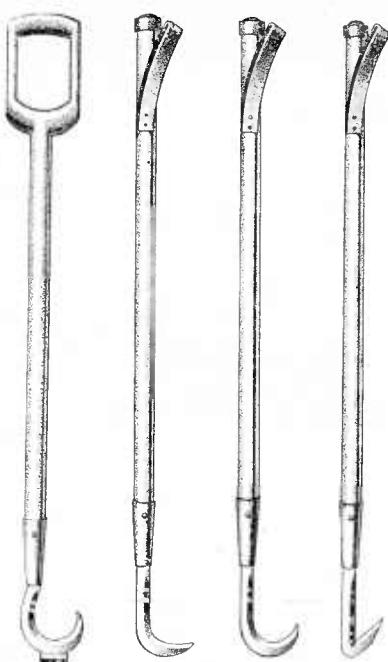


FIGURE 27.—Homemade raspberry-cane cutters used to cut out old canes and superfluous new ones. The total length of the cutters is about 34 inches. Straps on the handles of those at the right enable the worker to maintain a firm grip.

all bent over in the same direction and held down by a clod of earth or a piece of old cane broken half in two. A furrow of earth is then thrown over them with a plow and

later smoothed by hand labor so that the canes are entirely covered. The labor required to do this is considerable, and records show that it costs from \$30 to \$40 per acre to cover the canes by this method and to uncover them the following spring.

Another method, used in Idaho, of covering extensive areas of black raspberries is to draw an implement like the one shown in figure 28 over the row of canes. The front is high and wide and the back low and narrow. When this is drawn over the bushes, the canes are left lying along the row close to the ground. Plows, one on each side of the row, are placed so that the plants are covered by the furrows thrown to the center from either side. Furrows 10 to 14 inches wide and not over 4 inches deep should be turned on the bushes. The size of the furrows will depend on the stand of canes. This implement with two plows attached can be drawn by two horses and managed by three men. About 10 acres per day can be covered at a cost of approximately \$1.25 per acre. If the implement is well made, it will not bruise the canes badly, and it can be constructed by any berry grower at a cost of only a few dollars.

The canes should be uncovered in spring before growth starts, but not until after danger from severe weather has passed. Sometimes a gradual removal of the soil will be found advantageous. The canes will then become hardened by degrees, and there will be less danger of injury to the buds.

DURATION OF THE PLANTATION

The factors which determine the number of years a plantation will be profitable are not entirely understood, but to a large extent

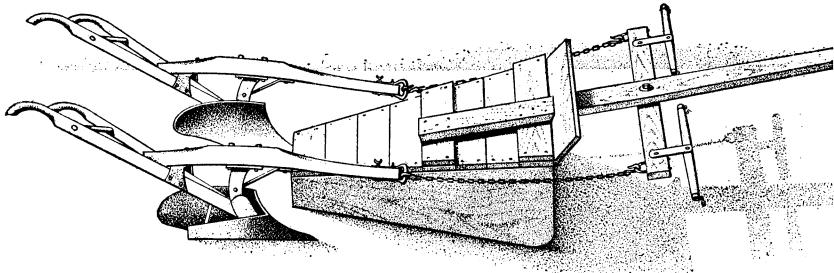


FIGURE 28.—Implement used in covering raspberry canes for winter protection. The evener must be made long enough to allow the horses to pass one on each side of the row.

they depend on the care given it. In the Puyallup Valley of Washington, some red raspberry plantations have been bearing good crops for 20, 25, and even 35 years and show no signs of becoming less fruitful. In the eastern United States occasional raspberry fields nearly as old are still in good condition, and small patches are much older. The canes in such fields have been thinned regularly and the moisture supply kept up by constant cultivation and by furnishing a plentiful supply of humus. In the care ordinarily given the average plantation the moisture supply is allowed to become deficient at times, and the new canes do not have an opportunity to

develop as they should. Sometimes black and purple varieties are allowed to bear so heavily that they cannot send up new canes, and such plants die. Often diseases and insects affect a plantation so that it becomes unprofitable. By systematic pruning, by maintaining the humus and fertility of the soil, and by constant cultivation the life of the plantation should be extended indefinitely. Perhaps the average length of life of a plantation in the Eastern States is 8 to 10 years for red raspberries, and 6 to 8 years for black and purple raspberries.

HARVESTING

Raspberries should be handled as carefully as possible in harvesting, in order to avoid injuring them. The subsequent behavior of the fruit on the market depends in a large measure upon the care used in picking and handling. Berries injured or bruised in handling, or soft from being overripe or from rainy weather, are attacked quickly by certain mold fungi which cause their decay. To avoid as much injury as possible in picking, three fingers always should be used; very few berries should be held in the hand at one time; the berries always should be placed, not dropped, in the basket or cup; all decaying, overripe, and injured berries should be discarded; and no later handling of the berries in the basket should be allowed for any purpose.

Picking must be done at least two or three times each week, depending on the locality, the variety, and weather conditions. In the Northwest, berries for the fresh-fruit market are picked three times a week, but for the cannery only twice weekly. The Marlboro and Antwerp varieties are considered to increase in weight more than the Cuthbert when left for an extra day if to be sold to the cannery. In hot or wet weather picking may be required at least every other

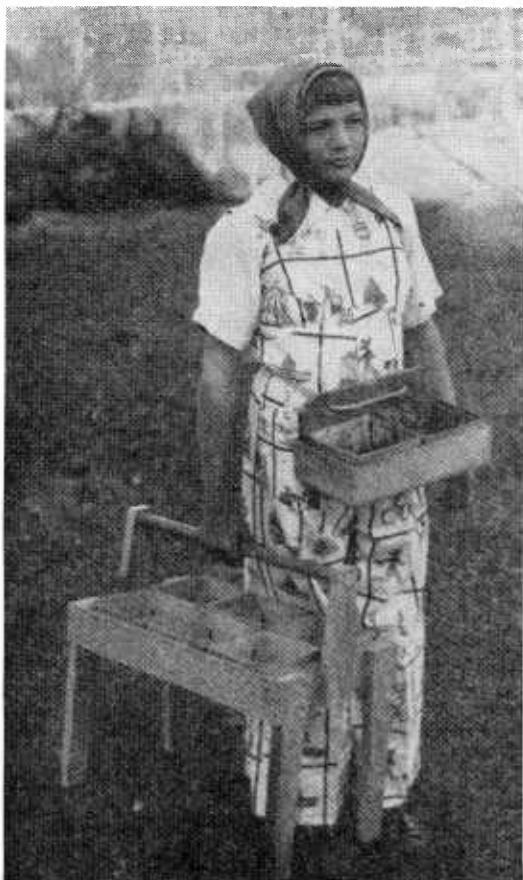


FIGURE 29.—Waist and hand carriers. The waist carrier holds two cups or baskets and the hand carrier six.

day. In the dry regions of the West every third or fourth day may be often enough. Some varieties rot on the bushes, Cuthbert, Herbert, King, and Eaton being especially bad in this respect. The Cuthbert and Lloyd George turn dark quickly. The Newman crumbles if picked too green, while Latham and Ohta keep well on the bushes.



FIGURE 30.—A picking carrier made to hold a quart basket. This carrier is suspended from the waist and is not likely to spill the berries when the picker is bending over. The filled baskets are placed in a hand carrier such as that shown.

of berries a day. The "harvester," shown in figure 31, is placed somewhat under the bush, and the bush is drawn over it by a short

Carriers used in picking are shown in figures 29 and 30. The berries should be picked into baskets carried in the waist carriers. As soon as the baskets are filled they should be transferred to the hand carrier, which always should stand in the shade.

In many sections the waist carrier holds two baskets, one for very ripe fruit and one for firm berries suitable for shipping. The very ripe fruit is used for canning and the firmer fruit for shipping to distant markets. When pickers are trained to use both baskets they lose very little time in the grading. Usually six to eight pickers per acre are needed in harvesting.

In western New York, where black raspberries are grown for drying, the berries in most cases are not picked by hand. Instead, a harvester or "bat" is used, with which a man can harvest from 5 to 8 bushels

wire hook held in the left hand. The ripe berries are then knocked off with a light wooden paddle, like that shown in figure 32, and fall into the harvester. More than half of the crop is secured the first time the field is gone over. Usually the remainder of the crop can be harvested by going over the field a second time. In some seasons it will be necessary to perform this operation a third time in order to get all of the fruit.

In Idaho, berries of the Gregg variety are allowed to dry on the bushes. The bushes then are cut and bundled. As soon as they are dry, the berries are separated by threshing. The berries, thus separated, hold the receptacle and have short stems, which are removed by running through a roller machine. This system is adapted only to sections with nearly rainless summers.

YIELDS

Yields from raspberry plantations vary greatly according to the varieties raised, the care given them, and the conditions under which they are grown. In the eastern United States it is agreed generally that in sections to which they are adapted the purple sorts are the most productive, the blackcaps next, and the red varieties the least productive. In the Northwest the red varieties are the most productive. The average yield for the United States is less than 1,000 quarts per acre. No grower, however, should be satisfied with such yields. Records of red-raspberry growers in New York indicate that the average yield of good fields is between 1,300 and 1,400 quarts per acre, while the best fields go as high as 4,000 quarts. Good fields of black raspberries in the same State average between 1,400 and 1,700 quarts per acre, and the purple varieties average between 1,700 and 2,300 quarts.

Yields in different sections as well as from different varieties vary greatly. In the Loveland section of Colorado the Marlboro variety will yield over 4,000 quarts per acre when protected during the winter and when other conditions are favorable. In the Puyallup



FIGURE 31.—Harvesting black raspberries for the evaporator with a harvester or "bat." The canes are drawn over the harvester with a wire hook held in the left hand, and the berries are knocked off with a paddle in the right hand.

Valley of Washington, a recent report gives the average yield of the 10 best fields of Cuthberts in 1930 as 10,386 pounds (7,500 quarts) per acre, though the average yields there are about 4,000 pounds (3,000 quarts) per acre. The Antwerp and Marlboro yield still more in that section. Eastern growers who have given their plantations care as intensive as is given in Washington have been getting yields nearly as large as those secured in that State. In the Northwest, Cuthbert plants averaging seven canes each, the canes having a diameter of seven-sixteenths inch at 6 inches above the ground and a diameter at least 90 percent as great at $5\frac{1}{2}$ feet above the ground, may be expected to give their maximum yields. The yield decreases in the same proportion that the diameter of the canes at $5\frac{1}{2}$ feet decreases in comparison with the diameter at the base. The canes of the Marlboro and other sorts naturally taper more evenly when maximum crops are obtained.

PROPAGATION OF STOCK

Many growers having established plantations propagate their own stock. In order to produce new plants the canes of black and purple raspberries are bent over and the tips are buried to a depth of not less than 2 nor more than 4 inches. This should be done when the tip is lengthening rapidly and bearing small curved leaves. Tips of the new canes take root quickly and rapidly develop into strong plants if they are pointed straight downward in loose moist soil.

By the following spring the tips will have rooted and formed good new plants. The old canes should then be severed, leaving 4 to 8

inches of cane on the new plants which are to be set in the field, as shown in figure 3. In planting, however, this cane should be buried or cut off, leaving none of it above ground.

If the tips of the canes of black and purple varieties are pinched off when they are about 12 inches high, the canes will branch freely and produce a large number of tips for burying. For many growers the first harvest from both black and purple raspberry plantations is a crop of plants. In fact, a large number of the plants distributed by nurserymen are produced in this way by raspberry growers, who in turn sell them to nurserymen. As previously stated, the strongest tip plant will

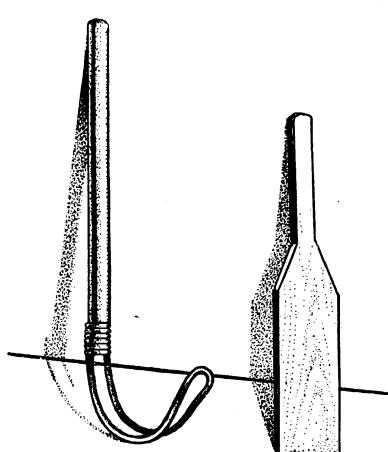


FIGURE 32.—Hook and paddle used in harvesting black raspberries in the Dundee section of New York.

make by far the best growth and should be selected for planting.

Red raspberries send up new canes from the base of the old canes, as do black and purple varieties. In addition, they send up suckers from underground roots at various distances from the crown of the

parent plant. In starting a new plantation the strongest of these suckers are used. If a quantity of plants for setting is needed each year for several years, it may prove desirable to take up all plants in a given part of the field, both the old ones and the suckers. By the following year a solid stand of plants suitable for setting will have sprung up from the pieces of roots left in the ground. When these are dug, another stand will grow for the following year if the ground is rich. If this practice is followed, the fruiting plantation need not be disturbed by digging up sucker plants. Sometimes growers wait until suckers appear in the spring and set these out. Such plants are small but make a rapid growth in cool cloudy weather and are very free from insects and diseases.

Raspberries may be propagated also by cuttings of the roots (red sorts), new canes (black sorts), or leaf buds (black sorts) if necessary. In ordinary practice, however, the cane cuttings and leaf buds are rarely used. Root cuttings are sometimes used in propagating red varieties.

VARIETIES

The varieties of red raspberries under cultivation have come from different parts of North America and Europe and are adapted to different conditions of environment and to different uses. Thus the Sunbeam and Ohta originated in South Dakota and generally withstand the trying conditions of the cold winters there. The Antwerp, which originated in Europe, where the winters are milder than in most raspberry-growing sections of this country, is grown only in the Pacific Coast States. The King has been a desirable variety throughout the region between the Mississippi River and the Appalachian Mountains, where raspberries succeed, but it is being replaced in part by the Latham, although the Latham is later. The Latham, originated by the Minnesota Agricultural Experiment Station, is hardy and is one of the most productive in all northern regions. It is rapidly becoming the leading red raspberry in much of the eastern United States.

In selecting the varieties of raspberries to cultivate in any locality it is usually important to consider (1) the hardiness of the canes, (2) the productiveness of the variety, and (3) its fitness for the particular purpose for which the crop is to be used. In the characterizations here given, special attention has been paid to these points. Thus, if in western New York varieties are desired through a long season, the following may be selected: For red varieties, the June for early, and the Cuthbert or Latham for late; for black varieties, the Farmer and Cumberland; and for purple varieties, the Columbian, Potomac, and Sodus. In the Middle West the list should include: For red varieties, the King or Chief and the Latham, or the Cuthbert in sheltered places; for black varieties, the Kansas, Farmer, and Cumberland; and for a purple raspberry, the Cardinal. In Oregon and Washington Cuthbert is still the principal variety grown, but Tahoma is a promising early, and Taylor and Washington are promising late sorts. Farmer is the only blackcap variety generally planted there now. In southern California the Surprise red raspberry has been considered the best variety, whereas

in central California the Ranere is the principal sort. The season of ripening for these raspberries is given in the characterizations.

These lists for the different sections are suggestive only, as in certain localities the varieties named may not prove equal to others. In the United States, as a whole, the Cuthbert was, until about 1920, the leading red variety. Growers seemed to prefer to plant a single variety rather than several varieties and commonly selected the Cuthbert, but the more productive Latham has supplanted it in most of the eastern United States.

In eastern districts there is now a shifting preference for varieties, due largely to difficulties in disease control. This makes suggestions in regard to varieties uncertain. Several new sorts are on trial. In New Jersey, however, the Ranere is the variety usually grown; in Minnesota the Latham, and in Colorado, the Marlboro. If varieties suited to special uses are desired, the following suggestions will prove helpful:

For jams and preserves, the Cuthbert, Columbian, and Potomac are especially desirable.

For canning, the Cuthbert among the reds; the Columbian and Potomac among those of purple color; and the Farmer and Cumberland among blackcaps. Other varieties may be equally desirable for some localities, but the commercial industries are based largely on those named above.

The following are among the most desirable raspberries in cultivation at the present time:

RED AND YELLOW VARIETIES

ADAMS 87 AND ADAMS 101.—Canadian origin. These two new varieties of red raspberries were purchased by a group of raspberry growers near Buffalo, N. Y. Both have been grown to a slight extent in that section. Adams 101 produces an especially firm berry.

ANTWERP.—European origin. Berries large, slightly conical, dark red, fairly firm, rather acid; season early, but later than Marlboro. Bush tender in the East, subject to crown gall; grown only on the Pacific coast, where it is used chiefly as a companion to the Cuthbert; in Washington, at least, it is more productive than the Cuthbert. Not hardy in most other parts of the United States.

CHIEF (Minn. 223).—Minnesota Experiment Station origin. Berries medium size, bright red, firm, very good quality, season early. Bush one of the hardiest of all commercial varieties, very vigorous and productive. The standard early sort for the upper Mississippi Valley region.

CUTHBERT.—New York origin. Berries large, conical, deep, rich crimson, firm, the standard in quality; season late. Bush suckers freely, only moderately hardy, being tender in Minnesota and other North Central States, sometimes also in exposed locations in New York and in the region near the Atlantic coast in New Jersey and New England; canes limber, very tall, requiring support. The berries are somewhat covered by the leaves, making picking difficult. The principal variety in Washington and Oregon and one of the best for canning and preserving. Adapted to sandy loam, but will do well on a wide range of soil types. Resistant to the wilt disease.

GOLDEN QUEEN.—New Jersey origin. Berries similar to the Cuthbert except in color, which is yellow. Bush very similar to the Cuthbert in all respects. Desirable for home use and for amateurs and adapted to the same conditions as the Cuthbert.

HERBERT.—Canadian origin. Berries large, somewhat conical, bright red, slightly softer than the Cuthbert; high in quality, midseason, ripening a little earlier than the Cuthbert. Bush suckers less than Cuthbert, subject to cane blight, usually hardy except in the Central States; prickly, vigorous, with

spreading growth. Grown in northern regions where the Cuthbert is not hardy, especially in New England and New York, where it is more productive than the Cuthbert.

JUNE (Ontario).—New York Experiment Station origin. Berries large, bright red, firm; season very early and long. Bush almost spineless, suckers less than Cuthbert, entirely hardy in the Eastern States, vigorous. Promising new variety for heavy soils in New York and New England, not widely tested elsewhere; sometimes lacking in dessert quality.

KING.—Virginia origin. Berries fairly large in sections to which it is adapted, bright red, firm, dropping from bushes when overripe; season early and long. Bush generally hardy, vigorous. An early variety grown chiefly in Minnesota and Michigan, but it has been largely replaced by Chief. Not generally desirable in New York and New England. Productive on clay loams.

LATHAM.—Minnesota Experiment Station origin. Berries large, medium red, very firm, season very late, later than Cuthbert. Bush hardy in eastern North Dakota, unusually vigorous, nearly thornless, and very productive. Leaves subject to mildew. Except in parts of New York and New England, wherever this variety has been tested east of the Rocky Mountains it has proved to be the most productive of the red raspberries. Though not of high dessert quality, it has good enough quality to become the standard red variety of the eastern United States. It is considered desirable for canning and freezing. Care should be used to secure stock free from mosaic disease. Susceptible to the wilt disease.

MARCY.—A new variety of good quality and large size adapted to the Northeast.

MARLBORO.—New York origin. Berries medium to large, bright red, firm; season early and long. Bush hardy, canes short and stout in the East but must be supported in Colorado and westward. Frequently grown as a companion to the Cuthbert, especially in Washington. Long an important variety in Colorado. Adapted to sandy loams somewhat heavier than those on which the Cuthbert does best. Susceptible to virus diseases and has therefore been replaced by other sorts in the Eastern States.

NEWBURGH.—New York Experiment Station origin. A new variety to be compared with Latham. Promising for the Northeastern States. Berries firmer and better in quality than Latham. Leaves subject to a leaf spot. Resistant to mosaic.

NEWMAN.—Canadian origin. Berries large, medium red, firm, but crumble somewhat, good dessert quality, midseason, about the season of Cuthbert. Bush hardy, erect, vigorous, and productive. Where tested this has been entirely hardy, productive, and free from mosaic disease. It is a desirable variety for the Northeastern States.

OHTA (Flaming Giant).—South Dakota Experiment Station origin. Berries large, light red, soft, acid; season very early. Bush very hardy, prickly, vigorous. Not very productive. Considered promising in the northern Great Plains area and in other sections having severe winters.

RANERE (St. Regis).—New Jersey origin. Berries small to medium, bright red, soft in the Eastern States, very firm in California; season very early and long; after the old canes have borne, the young canes begin bearing and in New Jersey and California bear freely until frost. Bush hardy, sends up suckers so freely that very thorough cultivation is necessary to keep them down; very susceptible to crown gall. Resistant to virus diseases. Long grown in New Jersey, where usually about five-sixths of the crop is borne in spring and the rest in autumn; should be tested carefully before it is planted heavily in regions where it has not yet been tried, as it will not bear much in the autumn in some regions, and not at all in the autumn in some seasons of drought. Leading sort in California, although susceptible to the bluestem or wilt disease.

SUNBEAM.—South Dakota Experiment Station origin. Berries large, bright to dark red, fairly firm, acid; season early. Bush very hardy, prickly, and vigorous, fairly productive. Recently introduced. Considered promising in the northern Great Plains area where other varieties are not hardy; should be tested further. Withstands drought well.

SURPRISE (California Surprise).—California (?) origin. Berries medium size, conical, fairly firm, good quality; season early, will bear a good second crop in California the first and second years after setting, but a smaller second crop thereafter; will bear some fruit in southern California almost every month in the year. Bush hardy in California, but hardiness unknown elsewhere; canes slender. The most desirable variety at the present time for southern California.

TAHOMA.—Washington Experiment Station origin. Bright red, firm, hardy, early, promising shipping variety in Pacific Northwest.

TAYLOR.—New York Experiment Station origin. A new midseason variety of good quality, and very large size. It seems to be more widely adapted than Newburgh and Marcy.

VAN FLEET.—United States Department of Agriculture origin. Berries medium size, soft, tart, very resistant to molds, pinkish red color, fair quality, very small seeds; season late, after other varieties are gone; bush more vigorous and productive than any other cultivated sort; resistant to ordinary diseases; tender; adapted to the southern United States from Washington, D. C., to northern Florida. This variety is recommended for the southern United States where other sorts cannot be grown; it is promising in the hot interior valleys of California.

VIKING.—Ontario Experiment Station origin. Berries large, somewhat conical, somewhat brighter red, firmer, slightly earlier than Cuthbert and similar in flavor. Berries much more easily picked and bushes much more productive than Cuthbert in the Northeast. A new variety of the Cuthbert type promising for the Northeastern States.

WASHINGTON.—Washington Experiment Station origin. A hardy new variety of Cuthbert season for testing in the Pacific Northwest for freezing and canning.

PURPLE VARIETIES

COLUMBIAN.—New York origin. Berries very large, rather soft, good quality, season late, about with Cuthbert. Bush usually hardy in the East, but not always hardy in the Middle West; very vigorous, very productive. One of the best canning raspberries and grown more extensively than any other purple variety, but stock badly affected with virus diseases.

POTOMAC.—United States Department of Agriculture origin. Berries large, firm, tart, season late and long. Bush one of the hardest of all in the North and one of the best in the South; very productive. One of the best berries for canning and preserving.

SODUS.—New York Experiment Station origin. Berries very large, firm, good quality, late, not so disease-resistant as Potomac in the South.

BLACK VARIETIES

BRISTOL.—New York origin. Very promising new late variety.

CUMBERLAND.—Pennsylvania origin. Berries very large, firm; midseason. Bush usually hardy. Is more widely planted than any other black raspberry because of its productiveness and quality; frequently planted with the Plum Farmer.

PLUM FARMER (Farmer).—Ohio origin. Berries very large, firm; season early and short, ripening so quickly that the entire crop can be harvested in two or three pickings. Bush hardier than most blackcaps; withstands drought well. Desirable for planting with the Cumberland and for use in sections where black raspberries are grown for evaporating.

Gregg.—Indiana origin. Berries large, firm; midseason. Bush usually hardy and productive. Extensively grown, but being superseded by others in some sections.

KANSAS.—Kansas origin. Berries large, firm; season early. Bush somewhat tender. Grown in Michigan with the Cumberland; in some sections is being replaced by Farmer.

MUNGER.—Ohio origin. Preferred to other sorts by some in Oregon and Washington, but susceptible to mildew and being replaced by Farmer.

NAPLES.—New York Experiment Station origin. A promising new late variety.

OLDER.—Iowa origin. Berries large, rather soft. Bush vigorous, of a somewhat trailing nature, very hardy for a black variety. Desirable for Iowa and Minnesota conditions.

BLACK PEARL (Pearl).—Missouri origin. Berries large, firm; season early and short. Bush hardy. Grown extensively in Kansas, Missouri, and Michigan, but not widely tested elsewhere. Especially desirable as a companion to the Cumberland or Gregg in the above-named States. Very promising at the Maryland Agricultural Experiment Station.

AUTUMN-FRUUITING VARIETIES

Certain varieties of red raspberries will fruit on the young canes in late summer. The best-known variety having this characteristic is the Ranere (*St. Regis*), which is grown extensively in New Jersey and central California and is the leading variety also in Maryland and Virginia. Other varieties in the trade are the Erskine, which often has crumbly or imperfectly developed fruit, and La France. The latter variety is a European sort and not hardy except on the Pacific coast. Both Ranere and La France are proving of value in California. The Indian Summer, recently introduced, has proved superior at some points in the Northeast. It has large fruit of high flavor. During seasons with rainy summers or under irrigation these varieties will produce considerable fruit in the late summer and autumn months, but when the moisture is deficient they cannot develop good fruit. Growers in New Jersey frequently market large quantities of fruit in August and September, and under conditions similar to those in New Jersey autumn-fruuiting varieties are likely to prove desirable.

HYBRID AND RELATED FORMS

At present there is in the trade in this country but one hybrid, the Ness, between the common forms of raspberry and other species of *Rubus* known to be valuable for its fruit, and there are no hybrids between the raspberry and other fruits. This one hybrid is the result of crossing the raspberry and a southern form of dewberry or blackberry and was originated at the Texas Agricultural Experiment Station. Although of high quality and productive, it is not likely to be of great commercial value, because the fruit does not pick off like the blackberry or pull off like the raspberry, but mashes in the hand or must be clipped off with the cap and a piece of the stem attached. However, it is worth growing for home use. New selections of this hybrid are said to pick off like the blackberry.

Several forms related to the raspberry are being propagated by the trade. Of these the form sometimes called the Golden Evergreen raspberry or Himalayan Golden raspberry (*Rubus ellipticus*) comes from India and southern China and will thrive only in the subtropical climates of southern California and southern Florida. The bush is perennial, and will grow to a height of 15 to 20 feet, with a spread of 30 feet in a few years. Usually it does not begin to bear until it is from 3 to 5 years old and then may sometimes bear annually more than 100 quarts per plant of golden-colored fruit which is about the size of a small black raspberry. The fruit is of only fair quality, but may be of some value for home use in regions where other berries will not grow. Other forms widely advertised at times are the Wineberry (*Rubus phoenicolasius*), which is a native of Japan and China, bearing cherry-red insipid fruit, the Strawberry-Raspberry (*Rubus illecebrosus*), a native of Japan, bearing scarlet fruit of poor quality, and the Chinese raspberry (*Rubus xanthocarpus*), a native of China, bearing a small quantity of sweet yellow fruit. None of these forms has proved to be of commercial value.

The Southern or Thunberg raspberry (*Rubus thunbergi*), a native of southern Japan and of China, has recently been introduced into the trade and recommended for southern Louisiana and Texas. It is rather closely related to the Strawberry-Raspberry.

USES

A large part of the raspberry crop is marketed fresh, to be used in the home for various culinary and dessert purposes. In addition, large quantities are canned or are preserved by freezing. The commercial canned pack in recent years (1925-1935) has averaged around 500,000 cases annually, valued at about \$1,000,000 per year, packed chiefly in Oregon, New York, Washington, and Michigan. The pack of Oregon and Washington consists primarily of red raspberries. This canned fruit is used largely for domestic consumption. The standard size can for packing raspberries is No. 2.

Raspberries to be used for pie-making, preserving, etc., are generally packed in the larger-sized No. 10 cans. In recent years, however, fruit to be used in this trade is largely packed in barrels, either with or without sugar, and frozen.

Raspberries are also made into jams, jellies, and preserves and quantities are used for making essences and extracts. The juice is sometimes expressed and sold for use as a beverage, and it is used also in the making of ice creams and sherbets.

Brief directions for utilizing raspberries follow. For detailed information, see United States Department of Agriculture Farmers' Bulletin No. 1762, "Home Canning of Fruits, Vegetables, and Meats."

Canning in tins.—Only cans that have been lacquered on the inside should be used for raspberries. Stems, leaves, and defective fruit should be discarded and the cans then filled with a certain weight of berries. Hot water or hot sugar sirup should be added, the can exhausted, the top inserted and sealed, and the whole can sterilized. The sterilizing process takes 12 minutes at 212° F. If a sirup is added it should be of the right degree of density to bring out the flavor of the particular variety. Usually the density will range from 15° to 50°. A 50° sirup is made by adding 8 pounds 6 ounces of sugar to 1 gallon of water, and a 15° sirup is made by adding 1 pound 7½ ounces to each gallon of water.

Canning in glass jars.—If there is no objection to shrinkage, the berries may be put in the jars, covered with a hot sirup of 15° to 50° density, and then sterilized for 20 minutes at 212° F. The covers should be fastened on immediately after cooking. If jars full of fruit are desired, the berries should be cooked before being packed in the jars and less sirup used.

Making jam.—For making jam the fresh berries may be thoroughly mashed or they may be left whole. If they are used whole some water must be added before cooking, and the cooking will take longer than if no water is added. Ordinarily sugar equal in weight to the berries should be added before cooking. If the fruit is very acid more sugar should be used; if the berries are mildly acid less sugar will be needed. The jam should be cooked at 212° F. for 20 minutes or until it is of the desired thickness and then placed in jars and sealed.

Frozen storage.—About 30,000 barrels of red and purple raspberries are put in cold storage each year to be used by the pie, preserve, and ice-cream industries. The berries are picked over, washed if necessary, and put in barrels, either with or without sugar. If in sugar, the proportion is 1 part sugar to 2, 3, or 4 parts berries, depending on the purpose for which they are to be used. The barrels must be placed in freezing storage promptly, usually at 0° F. for a few days and then at temperatures up to 20°. Since 1927 an increasing quantity has been frozen packed in small containers for home-consumer trade. These are mostly packed in the proportion of 1 part sugar to 3 parts berries.

DISEASES AND INSECTS

Several serious diseases (see Farmers' Bulletin 1488) of the raspberry are largely responsible for the decline in the production of this fruit in recent years. These are virus or mosaic diseases, crown gall, bluestem or wilt, and anthracnose. At the present time the control of these diseases is the most important factor in raspberry growing. Control of virus diseases and crown gall is effected through the planting of clean stock, and this stock has been difficult to secure. Anthracnose affects black and purple raspberries chiefly. Insect enemies of the raspberry are sometimes very serious in certain localities, but are of far less importance in the country as a whole than the diseases mentioned. Information regarding the control of diseases and insects may be obtained by writing to the nearest State agricultural experiment station or to the United States Department of Agriculture at Washington, D. C., and furnishing specimens of the insects and the affected parts.

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